

# UNCOVERING THE

# TRUE COST

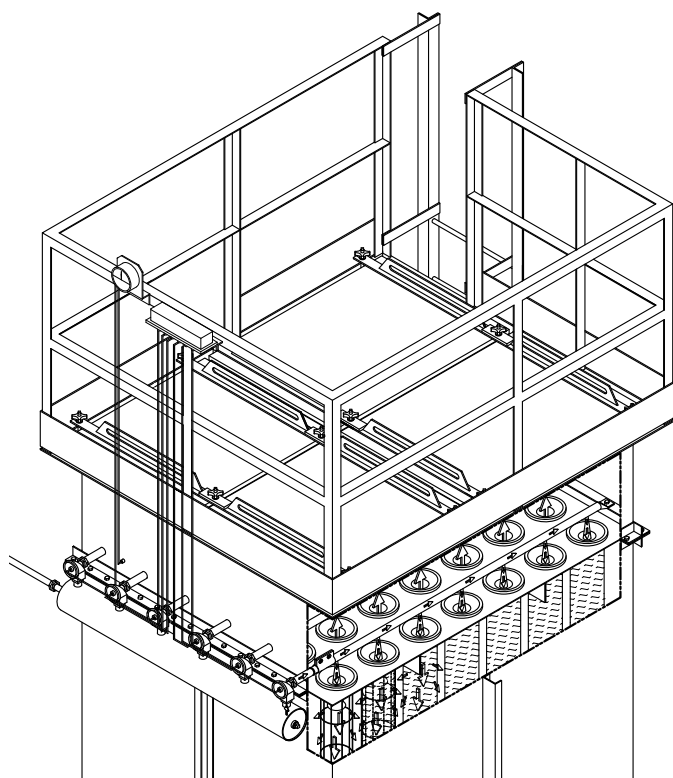


**Nathan Schindler, Evonik Corp. and Keith Ogilvie, National Filter Media Corporation, examine the true cost of ownership of cement plant baghouses.**

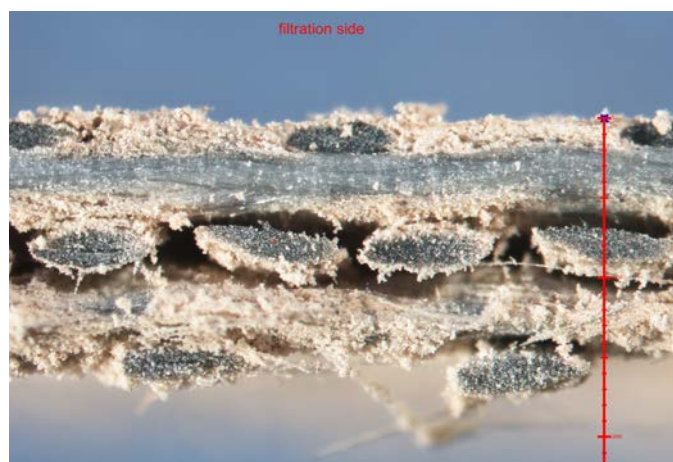


Over the past decade, the importance of filtration in the overall cost of cement production in the US has increased substantially. The Cement MACT regulations have increased the importance of filtration by reducing dust emissions requirements ten-fold. These low requirements must be monitored and maintained on a continuous basis. At the same time, demand on existing plants has increased significantly. Older plants that could

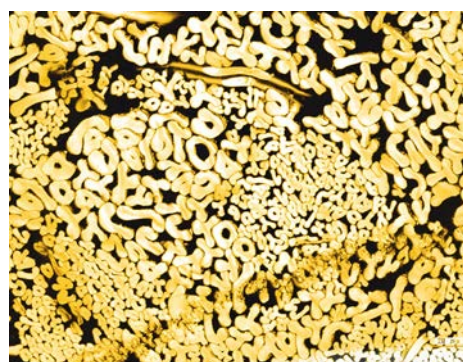
not be economically upgraded to meet the new regulations were shuttered while demand for clinker in the US increased steadily. Today, a poorly operating filter significantly impacts a cement plant's production reliability, maintenance costs, operating costs, and energy use. Evonik's P84® fibre has been used by cement plants around the world for over 20 years to cost-effectively improve the performance of cement plant filter units and



Typical pulse-jet fabric filter.



Glass-membrane fabric.



P84 fibre and felt.



reduce the total cost of ownership of pulse-jet fabric filters.

## Filtration – essential to cement plants

### Operational principal of a pulse-jet

Pulse-jet fabric filters have been adopted at cement plants due to their low overall operating costs, small footprint, and low emissions compared to electro-static precipitators and reverse air baghouses. Pulse-jet units have two sides: a dirty side and a clean side separated by a tube sheet. From the tube sheet, filter bags supported by cages prevent dust from flowing to the clean side of the filter, protecting the environment. As the dust accumulates on the dirty side of the bag, the pressure drop across the bag increases. Upon reaching a predetermined pressure setpoint, a blast of compressed air cleans the dust from the bags. When the unit is operating properly, pressure drop is low and consistent, pulsing frequency is low and steady, and bag life is long.

Maintaining and operating filtration units properly is critical to the success of cement plants. Poor performing filter units impact plant operation, maintenance costs and energy use. During the life of a filter unit, cement plants make many changes to increase production, switch fuels, improve product quality, and meet new and evolving environmental requirements. Too often, the original filter was not designed to meet these new conditions, generating extra maintenance and production costs due to inadequate performance of the original filter media. Fortunately, a smarter filter media can frequently be used to significantly reduce the cost of ownership of an existing unit. A cement plant will typically operate two categories of pulse-jet fabric filters: process filters (kiln-raw mill, clinker cooler,

coal and clinker mill) and dedusting filters. The continuous and efficient operation of process filters is paramount to the overall cement plant production as shutting down for unplanned maintenance will have a negative impact on the entire plant's profitability.

## Standard filter media

The most common membrane-coated filtration material for cement plants is ePTFE membrane laminated on a woven fibreglass base, typically known as 'glass-membrane'. When first installed, due to the small pore sizes, glass-membrane filter media captures more particulate matter, particularly PM2.5, and prevents dust penetration.<sup>1</sup> When applied under ideal conditions, glass-membrane filter bags can last for 5 years in a pulse-jet fabric filter. Unfortunately, many cement plants do not operate under ideal conditions over the long-term. After installation, plants will change fuels, increase production rates, change raw materials, change product mix, or enhance environmental controls. Plants around the world are switching to lower cost energy sources like refuse derived fuels, while also reducing the environmental impact of the cement plant. Unburned hydrocarbons from refuse derived fuels can blind glass-membrane bags. These changes in plant operation lead to damaged bags causing increased pressure drop, increased pulsing frequency, and increased emissions. Ultimately, reduced bag-life is observed, requiring unplanned maintenance or even unplanned shutdowns.

## Advantages of specialist filter media

P84 filter media allows cement plants to experience the benefits of a robust non-woven felt and superior filtration efficiency. Due to their unique, irregular multi-lobal shape, P84 fibres have the capacity to retain a permanent dust cake on the surface of the filter media, thereby meeting the same emissions criteria as a glass-membrane filter, but with a more robust and porous media that can withstand harsher operating conditions, such as increased air-to-cloth ratio, finer particles, and increased dust loading. After 12 months of service life, P84 filter media prevents emissions of fine (PM2.5) particles better than glass-membrane filter media.<sup>1</sup>

P84 filter media can be constructed in a variety of ways to cost-effectively take advantage of its unique qualities. P84 fibre can withstand operating and surge temperatures typical of cement kiln baghouses, up to 500°F for short-term temperature excursions. For cement kiln/raw mill baghouses, P84 dirty and clean side batts with PTFE scrim is commonly used.

In lower temperature applications, cement plants can take advantage of P84's unique surface-oriented dust capture by applying a cap layer of P84 to a standard non-woven

**Table 1. In cement plants, a variety of constructions can be used depending on the application.**

Filter Unit	Construction
Kiln/Raw mill	P84 felt
Clinker cooler	P84 cap on m-aramid
Cement mill	P84 cap on polyester
Coal mill	P84 cap on homopolymer acrylic
Alkali bypass	P84 + PTFE fibre

fabric. This stratification of fibres creates an effective filter media.

## Assessing the total cost of ownership of filter units

### Production reliability

Cement plants in the US must continuously meet strict emissions limits imposed by the US EPA. A single failed bag can require corrective action, including a kiln shutdown if the kiln baghouse or clinker cooler baghouse compartments cannot be isolated for on-line bag replacement. During a 4-day unplanned outage, the shutdown of a kiln producing 125 tph would experience production losses of 12 000 t. At US\$115/t of clinker, this would equate to a revenue loss of US\$1.4 million. Even a small reduction in the productivity of a clinker grinding mill can be significant. When pressure drop across the bags exceeds the capacity of the fan, production rates can be reduced. Over the course of a year, a 10% reduction in production for a 15 tph ball mill would be 12 000 tpy, equalling an annual loss of revenue of US\$1.4 million.

### Maintenance costs

Cement plants are operating lean and maintenance time for bag replacement can be considerable. Maintenance staff required to conduct bag changes are taken away from other necessary projects around the plant. Labour costs associated with frequent bag replacement can add up over time. For example, labour costs for bag replacement in a clinker cooler can be equal to bag costs over a 2 year bag replacement cycle. A typical cost for a 3 man team dye testing a clinker cooler every other week at 8 hours per test would cost US\$31 000, approximately the same as a complete set of standard m-aramid filter bags.

### Operating costs

Increased pressure drop across the filter requires a significant increase in electrical

power. The power costs can be significantly more than the cost of filter bags. For example, 5000 glass-membrane filter bags a for kiln/raw mill pulse-jet fabric filter cost around US\$200 000. With a design pressure drop value of 6 in wc and US\$0.065/KWh electric cost, fan hp would cost US\$200 000/year. Over a 5 year bag life, if the pressure drop gradually increases from 6 in wc to 10 in wc at the end of life, the cumulative increased electrical operating cost is US\$330 000; more than 150% of the bag costs.

### Energy use

Finally, energy use is a significant issue for the cement industry. Cement production requires significant energy inputs including fuel, electricity for fan horsepower, and electricity for compressed air. With so much of the cost of cement production based on energy, cement plant operators are always seeking ways to reduce energy usage and implement lower cost fuels. Energy Star™ awards USA cement plants with recognition based on energy use. The electrical energy use of a kiln

**Table 2. Case studies showing reductions in ownership costs.**

United States – kiln/raw mill		
	Original	P84 upgrade
Filter media	22 osy fibreglass/membrane	16 osy P84 with PTFE scrim
Corrective actions	200 bags replaced in 18 months; bag life 24 months	1 bag replaced in 4 years; bag life 48 months
Production reliability	Production output reduced by regular bag changes	Production output not impacted by baghouse
Maintenance costs	Labour costs incurred for frequent bag changes; labour costs incurred for full bag replacement after 2 years	Minimal labour for corrective actions; full bag replacement reduced to 4 years; bag costs reduced.
Operating costs	ID fan horsepower costs and compressed air energy costs increased	Energy costs reduced by US\$200 000/year
Energy use	Electrical energy use increased causing increased CO <sub>2</sub> emissions from electrical generation unit	Energy use reduced by 2000 MWh/year; CO <sub>2</sub> reduced by 800 tpy
Europe – cement grinding mill		
	Original	P84 upgrade
Filter media	Fine fibre polyester cap on polyester	P84 & fine fibre polyester cap on polyester
Corrective actions	Bag life 7 months	Bag life 48 months
Production reliability	Production output reduced by outages	Production output not impacted by baghouse
Maintenance costs	Labour costs incurred for frequent full bag replacement after 7 months	Labour costs minimised with full bag replacement after 4 years
Operating costs	ID fan horsepower costs and compressed air energy costs increased	Energy costs reduced
Energy use	Electrical energy use increased	Electrical energy use reduced
Latin America – coal mill		
	Original	P84 upgrade
Filter media	Homopolymer acrylic/membrane	P84 cap on homopolymer acrylic
Corrective actions	Filter bags life limited to 6 – 8 months	No issues after 8 months with 2+ year bag life anticipated
Production reliability	Lost production due to fan limitations and shut downs for bag replacement	Production output not impacted by baghouse
Maintenance costs	Labour costs incurred for full bag replacement every 6 – 8 months. Bag costs increased.	Full bag replacement reduced to 2+ years; bag costs reduced by US\$30 000 over 2 years
Operating costs	ID fan horsepower costs and compressed air energy costs increased	Energy costs reduced by US\$50 000/year
Energy use	Electrical energy use increased causing increased CO <sub>2</sub> emissions from electrical generation unit	Energy use reduced by 400 MWh/year; CO <sub>2</sub> reduced by 200 tpy

baghouse can be significant. When pressure drop through the baghouse increases, more horsepower is required to drive the fan. A 4 in wc increase in pressure drop over 5 years on a 125 tph kiln increases energy use by approximately 5000 MWh.

## Solutions

As described above, the total costs of operating a filter unit can be significant, warranting an evaluation of potential upgrades. In many cases, a cement plant will be left with two choices: expanding the size of the filter unit or implementing a smarter filter media.

Adopting a smarter, P84 filter media can typically be accomplished during the annual outage. Existing cages can often be reused, and no significant changes to the unit design or operation are required. Alternatively, expanding a filter unit is very expensive, takes significant planning, frequently requires changes to plant layout, and in many cases is not feasible due to plant layout. Table 2 breaks down three case studies showing the reduction in ownership costs attained by cement plants that adopted a smarter P84 filter media.

## Conclusion

For over 20 years, P84 fibres have been used by cement plants around the world to reduce the total cost of ownership of their pulse-jet fabric filters. The authors would be glad to review the details of these case studies with cement plant operators. For cement plants located in the US or Canada, services are available to evaluate the true cost of ownership of pulse-jet fabric filters. ■

## References

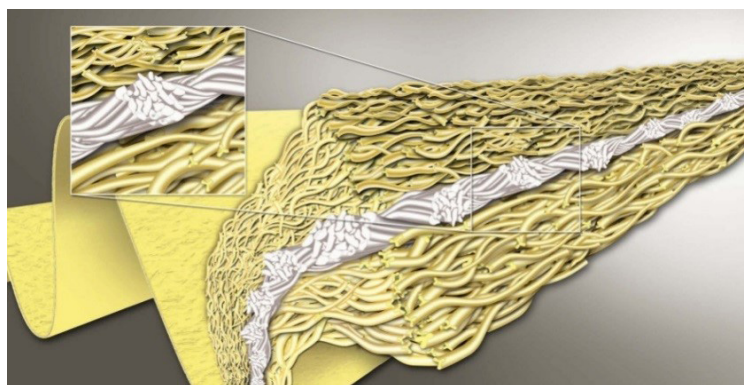
1. HARFMANN, P. and RUOFF, G., 'Filter media today and future requirements', *Technical Textiles*, vol. 51, no. 2, (2008), pp. 86 – 89.

## About the authors

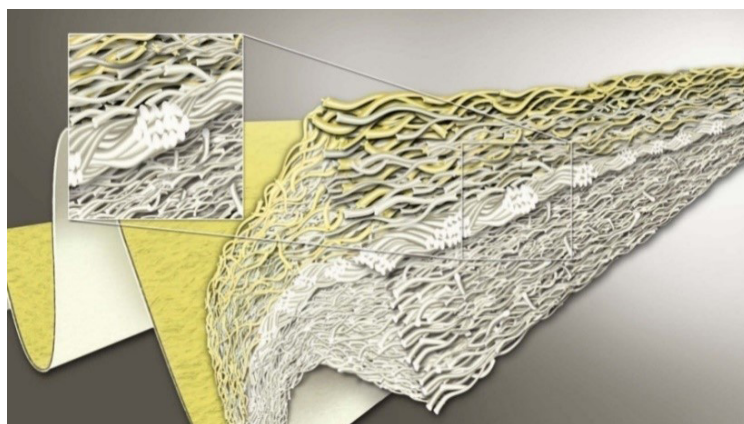
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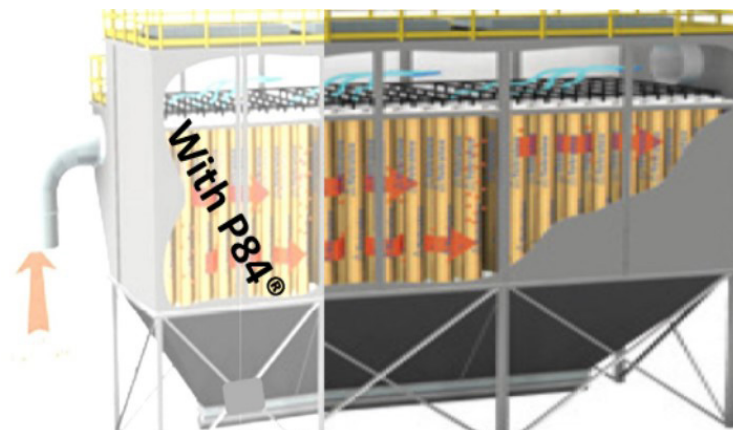
Keith Ogilvie is Director of Technical Sales for National Filter Media. Keith has more than 34 years of experience in the operation and maintenance of air pollution control systems (a.k.a. fabric filter baghouses, electrostatic precipitators and cartridge collectors). Keith has industry expertise in the application of textiles, ePTFE membrane laminates and fibres for use in the collection and control of industrial dry and wet particulates.



**P84 fibre with PTFE scrim.**



**P84 cap.**



**Capital expansion or adopt a smarter filter media.**

# Is baghouse overload pigging your profits? Get more with P84® under the hood.



## High filtration efficiency leads to consistent low-pressure drops – saving energy and money!

### How does it work? The surface is the secret.

P84® fiber has 65% more surface area than a conventional round fiber due to its irregular multi-lobal shape which keeps filters cleaner over time. A high performance P84® filter bag recovers at the original pressure drop keeping energy costs low, production rates high and compliance with air emission regulations in line.

### Achieve the highest capacity at the lowest total cost of ownership with P84® filter media.

- Increase production reliability
- Reduce operating costs
- Reduce maintenance costs
- Reduce energy use
- Increase fuel flexibility

*It's like adding 40% more bags, without the time and expense of a baghouse expansion!*

## P84®

### Ask us how!

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